Root River Steelhead Facility
Fall 1997 - Spring 1998 Report

Bradley T. Eggold
Fisheries Management
Plymouth, Wisconsin 53073

Summary: A total of 4,102 chinook salmon, 7,645 coho salmon, 1,020 steelhead, 487 brown trout and 2 brook trout were examined at the Root River Steelhead Facility (RRSF) in fall 1997 and spring 1998.

Of the 4,102 chinook salmon examined at the RRSF in the fall of 1997, the majority of them (3,974 or 97%) were passed upstream. Only 128 chinook had to be sacrificed for either disease or contaminant analysis or were too weak to pass upstream.

Four consecutive years of stocking either Lake Ontario Strain (LOS) or Lake Michigan Strain (LMS) chinook salmon produced runs of 2+, 3+ and 4+ LMS chinook salmon in 1997. Lake Michigan strain chinook salmon returned as 2+ fish at 0.35% (346 fish) from the 1995 year class. Age 3+ fish from the 1994 year class returned at 0.81% (612 fish) and age 4+ fish from the 1993 year class returned at 0.06% (68 fish) which was 6 times higher then the return rate of similarly aged LOS chinook salmon. Age 2+ and 3+ LOS chinook salmon were considerably smaller than similarly aged LMS chinook salmon in both length and weight for both males and females.

The number of coho salmon returning to RRSF rose dramatically from 813 fish in 1994 to 3,321 fish in 1995 then 4,406 fish in 1996 and finally 7,645 in 1997. A total of 6,909 coho salmon were passed upstream in 1997, 65 were saved for contaminant or fish health analysis and 16 died in the facility.

In the fall of 1997, we saw the second adult return of coho salmon from the fall fingerling versus spring yearling stocking study fish. Age 2+ adult coho salmon stocked as yearlings returned at almost three times the rate as those stocked as fingerlings (11.03% vs. 3.83%). Age 1+ coho salmon from the 1996 year class returned differently based on the type of rearing method. Spring yearling raised coho salmon return at 0.25% (119 fish) compared to 0.04% (24 fish) for those stocked as fingerlings. This contrasts with the two previous year's data that showed much higher return rate for 1+ coho salmon from both treatments.

Steelhead returns were very similar in 97-98 compared to 96-97. Skamania comprised almost all of the fall run fish. Of the 638 steelhead examined at RRSF in the fall of 1997, 408 were taken to the Kettle Moraine Fish Hatchery for brood stock and 228 were passed upstream. This year's run was comprised of slightly older fish, primarily age 4+. Chambers Creek and Ganaraska comprised the bulk of the spring 98 run with similar ages to the previous year. A total of 382 steelhead returned to RRSF in the spring of 1998, with 100% passed upstream and 0 saved for contaminant or fish health analysis. In addition, the spring run was considerably lower than previous years due to an earlier run and lower water flows when the weir was in operation.

Based on the high variability of the population estimates in a given year the only significant changes that occurred in the 1997-98 runs were for Chambers Creek and Ganaraska steelhead. The estimated Chambers Creek population decreased from 5,014 ± 1,606 in 1996 to 501 ± 226 in 1997. The estimated Ganaraska steelhead population also decreased from 5,356 ± 1,753 in 1997 to 1,962 ± 1,067 in 1998. Reasons for the decrease may include: 1) a normal yearly fluctuation in the number of fish returning to spawn in the Root River; or 2) excellent water flow before the weir was in operation allowing the majority of fish to pass by the weir.

The Root River has historically been a tremendous source of fish for both anglers, who want to catch them and fishery managers, who want to study them. The river has been stocked with large numbers of salmonids. Past efforts by managers to study these fish populations have been very labor intensive. Portable weirs as well as electrofishing efforts have been implemented to sample fish. Both methods were very labor intensive, costly and provided only a fraction of the fisheries data that the Wisconsin Department of Natural Resources needs to manage the Lake Michigan fishery. To combat these problems the Root River Steelhead Facility (RRSF) was constructed in 1994 through a cooperative effort by the WDNR, Salmon Unlimited, City of Racine and the U.S. Fish and Wildlife Service. Its main purpose is to provide brood stock for the steelhead fishery in Lake Michigan but is an excellent backup to the Strawberry Creek Weir for chinook salmon and to the Kewaunee Weir for coho salmon. It also provides a unique educational tool for school groups and interested people.

In order to fully utilize the RRSF, a project was written in 1993 with the following objectives: develop a long term index of chinook/coho/steelhead populations in the Root River to track the 1) abundance of returning adults; 2) age-specific growth and condition factors; 3) size and age distribution of returning adults; and 4) return to creel of these species stocked in the Root River. This annual report addresses these objectives.

METHODS

During the operation of the RRSF, for all targeted species and finclips, a minimum of 100 fish sample per species per finclip was obtained. These fish were measured to the nearest millimeter, weighed to the nearest 0.10 lb, examined for finclips, gender and condition and either held for brood stock, passed upstream or sacrificed (fish health or contaminant analysis). The remaining fish were tallied by species, sex and finclip and passed upstream. All fish that were passed upstream were given an upper caudal clip for population estimates.

All non-targeted species or finclips were tallied by species, finclip and sex, caudally clipped and passed upstream. All coded-wire-tagged (CWT) fish were measured and weighed. Heads were removed from behind the opercular flap and frozen for later examination. Fish needed for other studies such as disease analysis, contaminant analysis or other studies were frozen for later examinations.

Population estimates

Population estimates for each species or strain were derived from one of two equations. For those species with adequate sample sizes, the following Petersen equation for mark and recapture was used

$$N = \frac{M * C}{R} \qquad (1)$$

where

N = size of population in the river
M = number of marked fish
C = number of recaptured fish
R= number of marked fish in recapture sample

with the appropriate sample standard deviation of

$$S(N) = \sqrt{\frac{M^2 * C * (C - R)}{R}} \qquad (2)$$

For those species with low sample sizes, the

Bailey's modified equation was used

$$N = \frac{M * (C + 1)}{R + 1} \quad (3)$$

with the appropriate sample standard deviation of

$$S(N) = \sqrt{\frac{M^2 * (C + 1) * (C - R)}{(R + 1)^2 * (R + 2)}} \quad (4)$$

Several studies along with the general objectives and methods outlined above, have been initiated using fish stocked into the Root River.

Chinook salmon strain evaluation

Chinook salmon harvests have been highly variable over the last 6 years. One reason may be the poor performance of the Lake Michigan strain (LMS) chinook salmon that seems to be highly susceptible to Bacterial Kidney Disease (BKD) (Peeters and Royseck, 1996). To address this problem, a Lake Ontario strain (LOS) chinook salmon was stocked in 1992 acquired from New York Department of Environmental Conservation (NYDEC). These fish were not experiencing a BKD outbreak and it was hoped they would survive better than the LMS chinook salmon. In 1993 through 1995, Lake Michigan strain (LMS) chinook salmon were stocked. All lots were marked with a distinctive finclip so that a comparison could be made on the return rates and survival of these two strains.

Accelerated growth fall fingerlings vs spring yearlings

The coho salmon harvest has declined from historical levels which prompted fish managers to closely scrutinize the methods used to raise coho salmon. Prior to 1988, most coho salmon were stocked as yearlings (age 1+) which provided a good harvest averaging 110,000 fish per year. Starting in 1988, coho salmon were stocked as accelerated growth fingerlings (0+). These fish spent less time in the hatchery and were cheaper to raise. Unfortunately, the switch to accelerated growth fingerlings was not properly evaluated and has possibly lead to declines in harvest which averaged 70,000 fish per year. To evaluate the impact of rearing techniques, both accelerated growth fingerling and yearling coho salmon from the same year class, were stocked into the Root River from 1994-1996. All three groups were marked with distinctive finclips and will be evaluated during fall spawning runs from 1994-1998.

Steelhead strain evaluation

Since the Root River has been a backup for steelhead brood stock collections and primary source since the RRSF was constructed, approximately 33,000 fish per steelhead strain have been stocked annually. Of continuing importance are the performance of these three strains of steelhead; Skamania, Chambers Creek and Ganaraska. Because each strain must be marked with a distinct finclip for correct brood stock identification, strain evaluations can be conducted including age of returning fish, return rates and population estimates. Starting in 1997, a third set of distinct finclips was added to the finclip rotation (Table 7). This will allow WDNR to more accurately access the age and performance of each steelhead strain.

Size and condition

Trends in size and condition of all species processed at RRSF have been calculated since 1994. Only fish for which both total length and weight were recorded were used in the calculations. Three measures of estimated weight

were calculated and analyzed including 1) average weight; 2) trophy weight (weight of the 95th percentile of the weight distribution); and 3) standard weight (predicted weight of a given length fish developed from a length-weight regression model.

RESULTS AND DISCUSSION

The fourth season of operation for the RRSF started on August 26, 1997 and concluded on April 9, 1998. A total of 4,102 chinook salmon, 7,645 coho salmon, 1,020 steelhead, 487 brown trout and 2 brook trout were examined.

CHINOOK SALMON

A total of 4,102 chinook salmon were examined at the RRSF in the fall of 1997. The majority of them (3,974 or 97%) were passed upstream (Table 3). Some of these were stripped of eggs or sperm but the majority of fish remained healthy enough to pass upstream. Only 128 chinook had to be sacrificed for either disease or contaminant analysis or were too weak to pass upstream. No eggs were collected this year at RRSF.

In 1997 based on an age-length key from 4,031 known aged finclipped and unclipped chinook salmon (see below), age 1+ fish comprised 2% of the total number examined, age 2+ were 32%, age 3+ were 58% and age 4+ were 8% (Table 4). Because the majority of chinook salmon returning to the RRSF were unclipped, a percentage based on approximated ages of measured clipped chinook salmon had to be applied to all unclipped fish in order to develop an age composition of the run.

The 1997 spawning run was comprised of much older fish compared to 1996. The run this year was heavily weighted to older fish with only 2% comprised of 1+ chinook salmon while 58% were 3+ chinook salmon compared to only 34% in 1996 (Table 4). This deviates slightly from the first three years of operation at the RRSF as well as the trends noted at the Strawberry Creek Weir for the past 3 years (Peeters and Royseck, 1997).

Since average weight is influenced by the age structure of returning salmon, the average weight increased by 1.0 lb. in 1997 compared to 1996. This corresponds to the shift in ages of returning chinook salmon to more older fish (Table 2, Table 4). Standard weight of chinook salmon has decreased slightly from a high in 1995 of 10.1 lbs. to 9.4 lbs. in 1997 (Table 2). This represents a drop of 0.4 lbs. from 1996. Trophy weight remained the same at 21.1 lbs.

Chinook salmon strain evaluation

Four consecutive years of stocking either LOS or LMS chinook salmon produced runs of 2+, 3+ and 4+ LMS chinook salmon (Table 6). Lake Michigan strain chinook salmon returned as 2+ fish at 0.35% (346 fish) from the 1995 year class. Age 3+ fish from the 1994 year class returned at 0.81% (612 fish). Age 4+ fish from the 1993 year class returned at 0.06% (68 fish) which was 6 times higher then the return rate of similarly aged LOS chinook salmon from the 1992 year class. In all cases, LMS chinook salmon returned at a higher percentage compared to similarly aged LOS chinook salmon. In addition, the total return rate for the 1992 year class LOS chinook salmon was only 0.24% compared to 2.02% from the LMS chinook salmon 1993 year class (Table 6)

Average lengths and weights of both strains are shown in Appendix A & B. Since no data were collected on Age 1+ LOS chinook salmon a comparison could not be made to the three years of LMS 1+ data. However by age 2+ and 3+, the LOS chinook salmon were considerably smaller than age 2+ and 3+ LMS chinook salmon in both length and weight for both males and females. It appears that based on return rates and size of returning chinook salmon, the LMS chinook salmon

are surviving better and growing bigger than LOS chinook salmon. Similar results were also recorded at BAFF, where both 2+ and 3+ LMS chinook salmon were larger than LOS chinook salmon (Peeters and Royseck, 1997).

COHO SALMON

A total of 7,645 coho salmon were examined at the RRSF from August 26 through November 14, 1997 (Table 7). The majority of coho salmon were passed upstream (6,909). These fish comprised 90% of all coho salmon processed through the RRSF. A total of 65 fish were saved for contaminant or health analysis and 16 died in the facility. Egg take (1.75 million) and sampling goals were successfully reached.

The number of coho salmon returning to the RRSF increased 74% over the 1996 numbers. In order to properly evaluate the accelerated growth fall fingerling versus spring yearling study, extra man power was added to the staff at RRSF to insure that all possible coho salmon returning to the Root River were captured in the facility. This undoubtedly lead to higher numbers of coho salmon as well as chinook salmon that were captured at the facility.

Percent age composition of returning coho salmon was disproportinately distributed between age 1+ and age 2+ fish. A total of 7,699 fish were used to determine that only 5% were age 1+ and 95% were age 2+ (Table 8). This contrasts with the two previous years in which the returning coho salmon were split 33/66 between the two ages.

Average and trophy weight decreased in 1997 compared to 1996 (Table 2). Average weight dropped 1.3 lbs. while trophy weight dropped 1.6 lbs. This does corroborate evidence from other sources that showed a drop in size of coho salmon in 1997. However, standard weight of coho salmon has been fairly constant over the past 4 years at about 3.6 lbs. (Table 2). Since this indicator is more statistically valid than either average and trophy weight, the size and condition of coho salmon appears not to have changed much over the last 4 years at RRSF.

Accelerated growth fall fingerlings vs spring yearlings

Age 1+ jack coho salmon, stocked as fingerlings in 1996, returned at 0.04% (241 fish) while those stocked as spring yearlings (1+) returned at a much higher rate (0.25%) (Table 10). This is similar to the previous fall, although the number returning were much lower in 1997.

Age 2+ adult coho salmon, stocked as spring yearlings in 1996, returned at 11.03% (4,478 fish) while those stocked as fall fingerlings in 1995 from the same year class returned at 3.83% (2,098 fish) (Table 10).

The average lengths and weights of precocious coho salmon (age 1+) from the two different stocking procedures from both the 1995 - 1997 year classes were almost identical for both males and females (Appendix C.). However, the majority of the jack returns were sexually mature males. The average lengths and weights of the 1995 year class of adult coho salmon (age 2+) from the two different stocking procedures were different. Coho salmon stocked as yearlings were heavier (5.1 compared to 4.2 lbs. - males; 4.4 compared to 3.7 lbs. - female) and longer (24.5 compared to 23.0 inches - male; 23.2 compared to 22.0 inches - female) (Appendix C).

Results from the first two mature year classes of coho salmon returning to RRSF suggest that the return rate was much higher for coho salmon stocked as yearlings compared to fingerling stocked fish. The 1994 year class yearlings returned 74% better while the 1995 year class yearlings returned 287% better compared to fingerlings.

STEELHEAD

A total of 1,026 steelhead were examined at the RRSF from August 26, 1997 to April 9, 1998. The majority of all fish (610 or 59%) were passed upstream (Table 11). Those steelhead harvested in late summer were Skamania strain (408) to be used for brood stock and those in spring were Chambers Creek and Ganaraska (0). A total of 8 fish were used for contaminant or disease analysis. The majority of fish returning in the spring were comprised of both Chambers Creek and Ganaraska strain steelhead while the fall run was mainly Skamania strain. Additionally, a total of 80,000 Chambers Creek eggs and 240,000 Ganaraska eggs were collected from fish returning to RRSF.

Steelhead strain evaluation

Based on age-length keys from 135 fall run and 287 spring run known aged finclipped steelhead the percent age composition of both runs could be calculated (Table 12. However, due to overlapping sizes of steelhead having the same finclips some of the ages had to be estimated. Skamania steelhead comprised all 135 of the fall fish with age 1+ comprising 0.0% of the total number, age 2+ were 4.4%, age 3+ were 14.2%, age 4+ were 67.2%, age 5+ were 9.6% and age 6+ were 4.4%. This year's spawning run was comprised of slightly older fish, primarily age 4+, compared to the 1996 run. The number of Skamania steelhead returning to the RRSF has declined every year since 1994 except in 1997 when 644 were captured at RRSF.

Chambers Creek and Ganaraska steelhead comprised all of the 382 fish used in the spring 98 analysis. The age breakdown was 15.3% for age 1+, 35.9% for age 2+, 37.6% for age 3+, 5.6% for age 4+, 5.2% for age 5+ and 0.4% for age 6+. These ages were very similar to those in the spring 1997 run.

The 1998 spring run had significantly higher percentage of 3+ fish with a much lower percentage of 5+ compared to the fall 1997 Skamania run. These differences are most likely due to specific characteristics of each strain. In addition, this was the first year of return from some of the steelhead clipped with the third set of finclips. A strong return of 1+ Ganaraska steelhead helped lower the age at return of the spring run fish.

Stocking densities are shown in Table 13. All three strains have been stocked in nearly equal numbers the past 8 years. Each strain receives a distinct finclip that alternate each year. Because of the overlap in sizes from steelhead with the same finclip, lengths and weights for each year class could not be accurately calculated. However, starting in 1997, we added a third set of distinct finclips which should allowed us to more accurately age finclipped steelhead and calculate the age composition of returning steelhead as well as length and weight at age for each year class. Appendix D shows the results for Ganaraska strain 1+ steelhead which averaged 420.0 mm and 3.3 kg for males and 502.5 mm and 5.5 kg for females. Data from subsequent years will be used to compare the length and weight at age for each strain.

POPULATION ESTIMATES

Each fish that was passed upstream of the RRSF received a caudal clip which can be identified by a creel clerk during the recapture phase of the population estimate. An estimated 5,127 ± 436 chinook salmon were present during the fall run while 7,983 ± 436 coho salmon were calculated to be in the Root River (Table 14). Population estimates for steelhead were highest for Ganaraska in the spring of 1998 at 1,962 ± 1,067 fish, followed by Skamania at 1,297 ± 509 and lastly Chambers Creek at 501 ± 226. Only coho salmon showed a significant increase in population size

from the 1996 spawning season while both the Chambers Creek and Ganaraska steelhead population size decreased in 1998.

REFERENCES

Peeters. P and K. Royseck. 1997. Harvest, Age and Size at age of chinook and coho salmon at Strawberry Creek Weir and Besadny Anadromous Fisheries Facility, Fall 1997. Wisconsin Department of Natural Resources, Sturgeon Bay, WI.

Table 1. Summary of chinook salmon, coho salmon, steelhead, brown and brook trout captured at the Root River Steelhead Facility, 1994-98, including number of fish harvested, passed upstream and sampled.

CHINOOK SALMON

Harvest Year	Number of fish harvested	Number passed upstream	Number of misc. samples	Total number
Fall - 94	129	1,726	3	1,858
Fall - 95	300	2,663	16	2,979
Fall - 96	62	5,440	87	5,589
Fall - 97	0	3,974	128	4,102

COHO SALMON

Harvest Year	Number of fish harvested	Number passed upstream	Number of misc. samples	Total number
Fall - 94	285	513	15	813
Fall - 95	1,191	2,115	15	3,321
Fall - 96	161	3,940	305	4,406
Fall - 97	655	6,909	330	7,894

STEELHEAD

Harvest Year	Number of fish harvested	Number passed upstream	Number of misc. samples	Total number
Fall - 94	218	583	47	848
Spring - 95	120	2,582	18	2,720
Fall - 95	330	208	0	538
Spring - 96	150	2,970	49	3,169
Fall - 96	248	105	0	353
Spring - 97	2	2,918	125	3,045
Fall - 97	408	228	8	644
Spring - 98	0	382	0	382

BROWN TROUT

Harvest Year	Number of fish harvested	Number passed upstream	Number of misc. samples	Total number
Fall - 94	0	259	0	259
Fall - 95	46	645	0	691
Spring - 96	0	4	0	4
Fall - 96	70	244	0	314
Spring - 97	0	2	0	2
Fall - 97	114	369	3	486
Spring - 98	0	2	0	2

BROOK TROUT

Harvest Year	Number of fish harvested	Number passed upstream	Number of misc. samples	Total number
Fall - 94	0	160	0	160
Spring - 95	0	1	0	1
Fall - 95	0	6	0	6
Fall - 96	0	5	0	5
Fall - 97	0	2	0	1

Table 2. Average weight, average length, standard and trophy (95th percentile) weight for the four major salmonid species returning to the Root River Steelhead Facility, 1994-1998

Season	Number used in analysis	Average Weight	Average Length	Standard Weight	Trophy Weight		
Chinook Salmon							
94-95	343	8.9 ± 5.3	27.7 ± 5.6	9.7	17.8		
95-96	443	12.0 ± 5.9	30.7 ± 5.2	10.1	21.0		
96-97	703	11.7 ± 5.7	30.7 ± 5.4	9.8	21.1		
97-98	490	12.7 ± 4.9	32.5 ± 4.4	9.4	21.1		
Coho Salmon							
94-95	208	1.5 ± 1.1	15.9 ± 2.5	3.7	3.0		
95-96	594	3.1 ± 2.5	19.6 ± 5.0	3.6	9.0		
96-97	1,273	5.1 ± 2.4	23.9 ± 4.7	3.5	8.3		
97-98	828	3.8 ± 1.8	21.8 ± 3.6	3.5	6.7		
Steelhead							
94-95	638	5.9 ± 2.8	25.4 ± 4.7	3.5	10.7		
95-96	963	6.2 ± 2.7	25.6 ± 4.3	3.7	11.0		
96-97	626	7.2 ± 2.4	27.4 ± 3.3	3.6	11.2		
97-98	522	5.8 ± 2.9	25.7 ± 4.9	3.4	11.2		
Brown Trout							
94-95	108	4.9 ± 1.5	22.1 ± 2.7	3.4	7.0		
95-96	201	5.3 ± 2.2	22.4 ± 3.3	3.6	9.0		
96-97	162	4.6 ± 2.1	21.4 ± 4.0	3.4	7.8		
97-98	250	6.7 ± 3.4	24.0 ± 3.7	3.8	14.1		

Table 3. Number of chinook salmon harvested, passed upstream and sampled at the Root River Steelhead Facility during fall 1997.

Date	Number of fish harvested	Number of fish passed upstream	Number of misc. samples[1]	Total number of fish
Aug 26	-	4	-	4
Aug 28	-	40	-	40
Sept 17	-	94	16	110
Sept 18	-	708	7	715
Sept 19	-	221	-	221
Sept 20	-	-	2	2
Sept 22	-	381	-	381
Sept 23	-	253	-	253
Sept 24	-	80	-	80
Sept 25	-	85	-	85
Sept 26	-	68	-	68
Sept 27	-	-	1	1
Sept 28	-	-	1	1
Sept 29	-	119	-	119
Sept 30	-	-	2	2
Oct 1	-	128	-	128
Oct 2	-	-	1	1
Oct 3	-	41	3	44
Oct 4	-	-	3	3
Oct 5	-	-	3	3
Oct 6	-	220	78	298
Oct 7	-	154	5	159
Oct 8	-	-	-	-
Oct 9	-	126	1	127
Oct 10	-	69	-	69
Oct 11	-	-	-	-
Oct 12	-	-	-	-
Oct 13	-	88	3	91
Oct 14	-	177	-	177
Oct 15	-	209	1	210
Oct 16	-	170	-	170
Oct 17	-	73	-	73
Oct 18	-	-	-	-
Oct 19	-	-	-	-
Oct 20	-	128	1	129
Oct 21	-	27	-	27
Oct 23	-	22	-	22
Oct 24	-	-	-	-
Oct 26	-	-	-	-
Oct 27	-	85	-	85
Oct 28	-	-	-	-
Oct 30	-	83	-	83
Nov 1	-	-	-	-
Nov 3	-	83	-	83
Nov 4	-	1	-	1
Nov 6	-	26	-	26
Nov 10	-	9	-	9
Nov 13	-	2	-	2
Nov 14	-	-	-	-
Totals	-	3,974	128	4,102

1 Fish collected and sacrificed for other studies (i.e. disease, contaminants)

Table 4. Estimated age composition of chinook salmon (sexes combined) examined at the Root River Steelhead Facility, 1994-1997. Age is based on age-length key developed from known aged finclipped chinook salmon. Total number represents the number of chinook salmon used in the analysis.

Year of Return	Percent Age Composition 1+	2+	3+	4+	Total Number
1994	39	45	16	-	1,809
1995	25	45	30	-	2,874
1996	31	30	34	5	5,425
1997	2	32	58	8	4,031

Table 5. Summary of chinook salmon stocking numbers by strain and finclip stocked into the Root River 1991-1997.

Year Stocked	Total Number	Strain	Finclip
1991	174,933	L. Michigan	none
1992	166,989	L. Ontario	RMLV
1993	99,345	L. Michigan	LMRV
	70,000	L. Ontario	none
1994	75,533	L. Michigan	LP
	60,000	L. Michigan	none
1995	99,000	L. Michigan	RP
	69,250	L. Michigan	none
1996	158,000	L. Michigan	none
1997	142,500	L. Michigan	none

Table 6. Return rate of chinook salmon at age and strain to the Root River Steelhead Facility in the fall of 1994-1997. Return rate expressed as a percent of the number of chinook salmon stocked in the Root River that were actually recovered at RRSF. Number of actual chinook salmon returning to the facility are in parentheses.

	PERCENT AGE AT RETURN				
	1+	2+	3+	4+	Total Return
1992 YEAR CLASS					
[1]L. Ontario (RMLV)	-	0.15 (245)	0.09 (152)	0.01 (17)	0.24 (414)
1993 YEAR CLASS					
L. Michigan (LMRV)	0.33 (323)	0.78 (775)	0.85 (840)	0.06 (68)	2.02 (2,006)
1994 YEAR CLASS					
L. Michigan (LP)	0.10 (73)	0.58 (440)	0.81 (612)		
1995 YEAR CLASS					
L. Michigan (RP)	0.19 (189)	0.35 (346)			

[1] Total return for the L. Ontario strain chinook salmon from the 1992 year class was calculated only using ages 2-4. Actual total return rate was probably higher for this stocking.

Table 7. Number of coho salmon harvested, passed upstream and sampled at the Root River Steelhead Facility during fall 1997.

Date	Number of fish harvested	Number of fish passed upstream	Number of misc. samples[1]	Total number of fish
Aug 26	-	-	-	-
Aug 28	-	-	-	-
Sept 17	-	14	-	14
Sept 18	-	14	-	14
Sept 19	155	72	-	227
Sept 20	-	-	-	-
Sept 22	-	49	-	49
Sept 23	-	267	-	267
Sept 24	-	217	-	217
Sept 25	100	75	1	176
Sept 26	200	57	-	257
Sept 27	-	-	-	-
Sept 28	-	-	-	-
Sept 29	200	199	5	404
Sept 30	-	-	2	2
Oct 1	-	247	-	247
Oct 2	-	-	2	2
Oct 3	-	211	7	218
Oct 4	-	-	3	3
Oct 5	-	-	2	2

Oct 6	-	407	5	412
Oct 7	-	263	5	268
Oct 8	-	-	1	1
Oct 9	-	51	14	65
Oct 10	-	100	6	106
Oct 11	-	-	10	10
Oct 12	-	-	14	14
Oct 13	-	114	11	125
Oct 14	-	479	8	487
Oct 15	-	391	13	404
Oct 16	-	243	10	253
Oct 17	-	121	39	160
Oct 18	-	-	3	3
Oct 19	-	-	6	6
Oct 20	-	176	35	211
Oct 21	-	416	9	425
Oct 23	-	25	3	28
Oct 24	-	-	1	1
Oct 26	-	-	3	3
Oct 27	-	98	3	101
Oct 28	-	561	83	644
Oct 30	-	151	-	151
Nov 1	-	-	2	2
Nov 3	-	201	12	213
Nov 4	-	1019	10	1029
Nov 6	-	59	-	59
Nov 10	-	574	2	576
Nov 13	-	31	-	31
Nov 14	-	7	-	7
Totals	655	6,909	330	7,894

1 Fish collected and sacrificed for other studies (i.e. disease, contaminants)

Table 8. Estimated age composition of coho salmon (sexes combined) examined at the Root River Steelhead Facility, fall 1994-97. Age is based on age-length key developed from known aged finclipped coho salmon. Total number represents the number of coho salmon used in the analysis.

Year of Return	Percent Age Composition 1+	2+	Total Number
1994	53	47	780
1995	24	76	3,049
1996	32	68	4,211
1997	5	95	7,699

Table 9. Summary of coho salmon stocking numbers by strain and finclip stocked into the Root River 1993-1997. REL = red elastomer mark in adipose tissue of left eye.

Year Stocked	Total Number	Strain	Finclip	Age
1993	-			
1994	66,080	L. Ontario	none	Spring Yearling 1+
	55,954	L. Ontario	RMLP	Fall Fingerling 0+
	50,389	L. Michigan	RP	Spring Fingerling 0+
1995	65,100	L. Michigan	RMRP	Spring Yearling 1+
	54,832	L. Michigan	RMLV	Fall Fingerling 0+
1996	40,590	L. Michigan	RMRV	Spring Yearling 1+
	63,697	L. Michigan	LP	Fall Fingerling 0+
1997	48,107	L. Michigan	RP	Spring Yearling 1+
	6,668	L. Michigan	REL	Spring Yearling 1+
	4,208	L. Michigan	none	Spring Yearling 1+
	20,604	L. Michigan	none	Fall Fingerling 0+

Table 10. Return rate of coho salmon (percent and number) at age and stocking treatment to the Root River Steelhead Facility in the fall 1994-1997 based on year class. Return rate expressed as a percent of the number of coho salmon stocked in the Root River that were actually recovered at RRSF. Number of actual coho salmon returning to the facility are in parentheses.

		PERCENTE AGE AT RETURN	
Year Class	Stocking Treatment	1+	2+
1992	Fall Fingerling (RPLV)	-	0.88 (303)
1993	Spring Yearling (none)	0.71 (472)	3.20 (2,100)
1994	Fall Fingerling (RMLP)	0.88 (495)	1.50 (864)
	Spring Fingerling (RP)	0.59 (297)	0.00 (8)
	Spring Yearling (RMRP)	0.41 (266)	2.60 (1,700)
1995	Fall Fingerling (RMLV)	0.69 (381)	3.83 (2,098)
	Spring Yearling (RMRV)	2.09 (847)	11.03 (4,478)
1996	Fall Fingerling (LP)	0.04 (24)	
	Spring Yearling (RP)	0.25 (119)	

Table 11. Number of steelhead harvested, passed upstream and sampled at the Root River Steelhead Facility during fall 1997 and Spring 1998.

Date	Number of fish harvested	Number of fish passed upstream	Number of misc. samples[1]	Total number of fish
Aug 26	176	4	-	180
Aug 28	65	-	-	65
Sept 17	-	1	-	1
Sept 18	-	-	1	1
Sept 19	136	8	-	144
Sept 20	-	-	-	-
Sept 22	-	52	-	52
Sept 23	-	16	-	16
Sept 24	-	14	-	14
Sept 25	-	11	-	11
Sept 26	-	10	-	10
Sept 27	-	-	-	-
Sept 28	-	-	-	-
Sept 29	8	22	-	30
Sept 30	-	-	-	-
Oct 1	-	8	-	8
Oct 2	-	-	-	-
Oct 3	-	3	-	3
Oct 4	-	-	-	-
Oct 5	-	-	-	-
Oct 6	-	22	-	22
Oct 7	-	10	-	10
Oct 8	-	-	-	-
Oct 9	-	26	2	28
Oct 10	-	6	1	7
Oct 11	-	-	-	-
Oct 12	-	-	1	1
Oct 13	-	2	-	2
Oct 14	-	2	-	2
Oct 15	-	2	-	2
Oct 16	-	-	-	-
Oct 17	-	-	2	2
Oct 18	-	-	-	-
Oct 19	-	-	-	-
Oct 20	-	3	1	4
Oct 21	23	1	-	24
Oct 23	-	-	-	-
Oct 24	-	-	-	-
Oct 26	-	-	-	-
Oct 27	-	-	-	-
Oct 28	-	-	-	-
Oct 30	-	-	-	-
Nov 1	-	-	-	-
Nov 3	-	2	-	2
Nov 4	-	-	-	-
Nov 6	-	-	-	-
Nov 10	-	3	-	3
Nov 13	-	-	-	-
Nov 14	-	-	-	-
Mar 3	-	68	-	68
Mar 27	-	120	-	120
Apr 2	-	127	-	127
Apr 9	-	67	-	67
Totals	408	610	8	1,026

1 Fish collected and sacrificed for other studies (i.e. disease, contaminants)

Table 12. Estimated age composition of steelhead (sexes combined) examined at the Root River Steelhead Facility, 1994-1998. Age is based on age-length key developed from known aged finclipped steelhead. Total number represents the number of steelhead lengths used in the analysis.

Year of Return	Percent Age Composition 1+	2+	3+	4+	5+	6+	Total Number
Fall - 1994	8.9	7.5	43.2	34.2	6.2		146
Spring - 1995	7.3	31.3	38.0	12.7	10.7		450
Fall - 1995	15.6	12.2	21.8	49.7	0.7		147
Spring - 1996	11.0	36.1	33.1	9.1	10.1	0.6	692
Fall - 1996	-	26.3	36.8	5.3	31.6		21
Spring - 1997	1.0	22.1	42.5	22.5	10.5	1.4	483
Fall - 1997	-	4.4	14.2	67.2	9.6	4.4	135
Spring - 1997	15.3	35.9	37.6	5.6	5.2	0.4	287

Table 13. Summary of steelhead stocking densities and strain stocked into the Root River 1990-1997.

Year Stocked	Total Number	Strain	Finclip
1990	35,370	Skamania	RM
	35,008	Chambers Cr.	LM
	34,761	Ganaraska	ARV
1991	43,622	Skamania	ARM
	35,022	Chambers Cr.	ALM
	37,035	Ganaraska	ALV
1992	39,383	Skamania	RM
	36,600	Chambers Cr.	LM
	34,629	Ganaraska	ARV
1993	35,276	Skamania	ARM
	27,963	Chambers Cr.	ALM
	37,781	Ganaraska	ALV
1994	30,417	Skamania	RM
	35,124	Chambers Cr.	LM
	34,759	Ganaraska	LV
1995	37,347	Skamania	ARM
	37,819	Chambers Cr.	ALM
	34,494	Ganaraska	ALV
1996	34,254	Skamania	RM
	34,579	Chambers Cr.	LM
	35,404	Ganaraska	ARV
1997	35,262	Skamania	RMRV
	35,024	Chambers Cr.	LMLV
	35,201	Ganaraska	BV

Table 14. Population estimates for chinook, coho and steelhead salmon returning to the Root River in 1994 - 1998. No estimates for coho salmon in 1994 could be calculated because of small sample size. s.d. = standard deviation.

Year and species	Number of marked fish	Number of recaptured fish	Number of marked fish in recapture sample	Population size (± 1 s.d.)
Fall - 94				
Chinook	1,720	143	44	5,590 ± 701
Coho	513	2	0	-
Skamania	556	22	6	1,827 ± 539
Spring - 95				
Chambers Cr	1,653	117	45	4,298 ± 503
Ganaraska	453	74	11	2,718 ± 691
Fall - 95				
Chinook	2,663	36	21	4,478 ± 594
Coho	1,354	33	13	3,288 ± 651
Skamania	482	36	6	2,547 ± 811
Spring - 96				
Chambers Cr	1,045	48	28	1,765 ± 206
Ganaraska	1,457	77	31	3,551 ± 475
Fall - 96				
Chinook	5,440	37	36	5,587 ± 147
Coho	3,940	9	9	3,940 ± 0
Skamania	105	29	0	3,150 ± 2,189
Spring - 97				
Chambers Cr	900	38	6	5,014 ± 1,606
Ganaraska	139	23	5	5,356 ± 1,753
Fall - 97				
Chinook	3,974	40	31	5,127 ± 436
Coho	6,909	52	45	7,983 ± 436
Skamania	228	16	2	1,297 ± 509
Spring - 98				
Chambers Cr	93	15	2	501 ± 226
Ganaraska	217	17	1	1,962 ± 1,067

Appendix A. Average length (mm) and weight (kg) by age, sex and year of return of **Lake Michigan strain chinook salmon** examined in the Root River, fall 1994-1997. M=males, F=females, L=length, W=weight, sd=standard deviation and n=sample size.

Year of Return			AVERAGE LENGTH AT AGE 1+	2+	3+	4+	5+
1994	M	$\bar{L}$ (sd)	559.9 (53.4)				
		range	410-661				
		n	95				
	F	$\bar{L}$ (sd)	531.2 (44.3)				
		range	460-588				
		n	9				
1995	M	$\bar{L}$ (sd)	551.8 (74.8)	782.0 (84.9)			
		range	466-754	491-999			
		n	21	108			
	F	$\bar{L}$ (sd)	-	796.0 (39.9)			
		range	-	752-848			
		n	-	8			
1996	M	L (sd)	579.7 (53.3)	761.4 (64.7)	916.1 (74.9)		
		range	490-795	577-880	720-1067		
		n	100	107	58		
	F	$\bar{L}$ (sd)	830.0 (21.2)	774.5 (95.5)	884.4 (52.8)		
		range	815-845	707-842	724-965		
		n	2	2	47		
1997	M	L (sd)		744.4 (53.6)	864.5 (84.4)	885.9 (104.3)	
		range		629-880	596-1008	665-1022	
		n		94	73	9	
	F	$\bar{L}$ (sd)		752.9 (83.4)	856.8 (49.4)	842.4 (74.5)	
		range		630-901	741-990	705-990	
		n		9	53	20	

Year of Return			AVERAGE WEIGHT AT AGE 1+	2+	3+	4+	5+
1994	M	$\bar{W}$ (sd)	1.8 (0.8)				
		range	0.5-6.9				
		n	95				
	F	$\bar{W}$ (sd)	1.6 (0.4)				
		range	1.0-2.2				
		n	9				
1995	M	$\bar{W}$ (sd)	1.8 (0.8)	4.9 (1.5)			
		range	0.9-4.1	1.4-8.6			
		n	21	108			
	F	$\bar{W}$ (sd)	-	6.0 (1.3)			
		range	-	4.5-7.7			
		n	-	8			
1996	M	L (sd)	2.0 (0.7)	4.4 (1.2)	7.7 (2.1)		
		range	1.1-5.6	1.6-7.4	3.7-12.5		
		n	100	107	58		
	F	$\bar{L}$ (sd)	6.0 (0.2)	4.9 (1.8)	7.7 (1.4)		
		range	5.9-6.1	3.6-6.1	4.9-10.8		
		n	2	2	47		
1997	M	L (sd)		3.9 (0.9)	6.2 (1.8)	6.7 (2.3)	
		range		2.1-6.7	2.4-10.2	3.3-11.0	
		n		94	73	9	
	F	$\bar{L}$ (sd)		4.5 (1.5)	6.6 (1.4)	6.3 (1.7)	
		range		2.3-6.9	4.0-11.0	3.8-10.8	
		n		9	53	20	

Appendix B. Average length (mm) and weight (kg) by age, sex and year of return of **Lake Ontario strain chinook salmon** examined in the Root River, fall 1994-1997. M=males, F=females, L=length, W=weight, sd=standard deviation and n=number.

Year of Return		AVERAGE LENGTH AT AGE					
			1+	2+	3+	4+	5+
1994	M	$\bar{L}$ (sd)		736.6 (80.1)			
		range		451-883			
		n		83			
	F	$\bar{L}$ (sd)		695.4 (125.9)			
		range		476-770			
		n		5			
1995	M	$\bar{L}$ (sd)			849.3 (129.4)		
		range			569-999		
		n			31		
	F	$\bar{L}$ (sd)			845.6 (59.0)		
		range			630-951		
		n			69		
1996	M	L (sd)				974.0 (0.0)	
		range				974	
		n				1	
	F	$\bar{L}$ (sd)				827.0 (1.7)	
		range				825-828	
		n				3	

Year of Return		AVERAGE WEIGHT AT AGE					
			1+	2+	3+	4+	5+
1994	M	$\bar{W}$ (sd)		4.1 (1.3)			
		range		0.8-7.1			
		n		83			
	F	$\bar{W}$ (sd)		3.7 (1.6)			
		range		1.1-5.1			
		n		5			
1995	M	$\bar{W}$ (sd)			6.6 (2.7)		
		range			1.8-13.2		
		n			31		
	F	$\bar{W}$ (sd)			6.9 (1.5)		
		range			2.3-10.5		
		n			69		
1996	M	L (sd)				10.1 (0.0)	
		range				10.1	
		n				1	
	F	$\bar{L}$ (sd)				6.8 (1.3)	
		range				5.9-8.3	
		n				3	

Appendix C. Average length (mm) and weight (kg) by stocking age, sex, age and year of return of finclipped **coho salmon** examined in the Root River, fall 1995-97. M=males, F=females, L=length, W=weight, sd=standard deviation and n=number.

LENGTH AT AGE

Year of Return			**Fingerling Stocked** 1+	**Fingerling Stocked** 2+	**Yearling Stocked** 1+	**Yearling Stocked** 2+
1995	M	$\bar{L}$ (sd)	392.9 (23.6)		388.4 (34.5)	
		range	338-444		315-577	
		n	100		134	
	F	$\bar{L}$ (sd)	426.5 (4.9)		541.0 (0)	
		range	423		541	
		n	2		1	
1996	M	L (sd)	380.8 (24.6)	690.6 (61.6)	418.3 (33.0)	669.3 (60.2)
		range	316-443	422-798	353-506	346-785
		n	99	112	99	259
	F	$\bar{L}$ (sd)		671.1 (41.6)	486.3 (95.1)	657.1 (38.1)
		range		392-769	392-665	530-741
		n		200	6	264
1997	M	L (sd)	385.1 (18.3)	585.8 (59.6)	402.1 (24.0)	622.3 (64.0)
		range	366-410	446-771	352-440	396-783
		n	7	120	29	130
	F	$\bar{L}$ (sd)		559.5 (45.2)	408.9 (28.3)	589.0 (52.1)
		range		445-688	353-459	411-688
		n		133	9	153

WEIGHT AT AGE

Year of Return			**Fingerling Stocked** 1+	**Fingerling Stocked** 2+	**Yearling Stocked** 1+	**Yearling Stocked** 2+
1995	M	$\bar{W}$ (sd)	0.6 (0.2)		0.6 (0.2)	
		range	0.5-0.9		0.5-1.8	
		n	100		134	
	F	$\bar{W}$ (sd)	0.9 (0)		1.8 (0)	
		range	0.9		1.8	
		n	2		1	
1996	M	L (sd)	0.5 (0.1)	3.0 (0.7)	0.7 (0.2)	2.7 (0.7)
		range	0.3-0.9	0.8-4.8	0.4-1.3	0.4-4.4
		n	99	112	99	259
	F	$\bar{L}$ (sd)		3.0 (0.6)	1.3 (0.8)	2.8 (0.6)
		range		0.6-5.2	0.5-2.8	1.1-4.6
		n		200	6	264
1997	M	L (sd)	0.5 (0.1)	1.9 (0.6)	0.6 (0.1)	2.3 (0.7)
		range	0.4-0.5	0.8-3.7	0.3-0.8	0.5-4.7
		n	7	120	29	130
	F	$\bar{L}$ (sd)		1.7 (0.5)	0.7 (0.1)	2.0 (0.6)
		range		0.8-3.6	0.5-0.9	0.6-3.5
		n		133	9	153

Appendix D. Average length (mm) and weight (kg) by year class, strain, sex and age of finclipped **steelhead** examined in the Root River, fall 1997-1998. M=males, F=females, L=length, W=weight, sd=standard deviation and n=number.

Year Class			LENGTH AT AGE 1+	2+	3+	4+	5+
1996							
	GANARASKA (BV)						
	M	L (sd)	420.0 (25.9)				
		range	348-466				
		n	43				
	F	$\bar{L}$ (sd)	502.5 (52.5)				
		range	450-555				
		n	2				

Year class			WEIGHT AT AGE 1+	2+	3+	4+	5+
1996							
	GANARASKA (BV)						
	M	W (sd)	3.3 (0.6)				
		range	2.0-4.8				
		n	43				
	F	$\bar{W}$ (sd)	5.5 (1.3)				
		range	4.2-6.8				
		n	4				